

## **Technologies to Improve Management and Treatment of Dairy Manure in California's San Joaquin Valley: an Environmental and Economic Assessment**

### **Executive Summary**

### **Introduction**

Dairies are important to California as a source of food and jobs. However, manure from California dairies, especially in the San Joaquin Valley, is associated with serious environmental problems, and the California dairy industry is facing rapidly increasing state and federal regulation over its role in pollution of air, land and water. There is a critical need to improve the management and treatment of manure to reduce environmental problems, while ensuring the economic viability of this essential agricultural industry.

A group of some 50 stakeholders representing federal and state agencies, local government, dairies and dairy industry organizations, public-interest non-profit organizations, and private technology providers, met for a conference (*"Waste to Watt's, or What?"*, Modesto Ag Center, October 13, 2004) to decide on critical next steps needed to implement new, improved technologies to manage and treat manure. There was broad agreement on the need for a rapid, objective assessment of which technologies were most likely to work in California's unique economic, regulatory, and meteorological conditions. The group proposed the creation of a Dairy Manure Technology Feasibility Assessment Panel to carry out this work.

The California Air Resources Board agreed to create and host the Panel. Members were drawn from government, industry, academia, and environmental and conservation groups. The Panel was convened in February 2005.

### **Goal**

The goal of the Panel was to evaluate technologies most likely to improve the management and treatment of dairy manure in the San Joaquin Valley, and to issue a report that includes:

- descriptions of technologies most likely to improve the management and treatment of dairy manure in the San Joaquin Valley;
- a list of technology providers with full contact information
- an assessment of each technology based on its environmental and economic performance, and technology development status;
- discussion of knowledge gaps where additional research is needed; and

- recommendations about which types of technologies might hold the most promise for improving management and treatment of dairy manure in the San Joaquin Valley.

## Criteria for Evaluating Technologies

Each technology will be evaluated for its impact on air, land and water quality, by-products, development status, economic performance, and quality of supporting data. Specifically,

- **Reducing environmental impacts.**
  - **Air pollutants.** The San Joaquin Valley does not meet Clean Air Act standards for particulate matter and ozone. Dairies are sources of ammonia (pre-cursor to formation of fine particulate matter) and volatile organic compounds (precursors to formation of both particulate matter and ground-level ozone). Dairies are also sources of methane and other global warming gases. We want to know the impact of each technology on reducing emissions of these air pollutants.
  - **Nutrients.** We also are concerned about reducing emissions of nitrogen and phosphorous compounds so we can improve water and soil quality.
  - **Salts.** Some technologies have no impact on salt loads, while others precipitate salts for possible export off-farm for sale and use in industrial processes.
  - **Others.** Other concerns include reducing odors and threats from pathogens.
- **Creating energy.** Some technologies, such as anaerobic digestion and direct combustion, can be a source of distributed power, which is useful to the dairy and increases California's energy independence.
- **Economic performance.** How much does each technology cost per cow? Per unit of milk produced? Per pound of pollutant removed from the environment? How does this compare with current standard practice? Does the technology also yield products that can offset the costs, such as energy, fertilizer, and compost? We will want to know construction, operation and maintenance costs.
- **Quality of Supporting Data.** We will want to know the sources and quality of the data submitted on each technology. In some cases objective evaluations already exist in the academic literature or at government agencies, or the technology may be well-known in the engineering world even if it has not yet been applied to dairy manure in California. In other cases, the panel will have to rely on data submitted by the private companies that provide the technology.
- **Development Status of the Technology.** Is this technology already commercially available? If not, how close is it? Is it already available for similar applications?

## **Technologies to be Assessed**

- “Advanced Integrated Wastewater Pond Systems” and “Controlled Eutrophication Process”
- Aerobic Digestion (e.g., Environmental Products & Technologies Corporation (<http://www.eptcorp.com>), and Water Pure Technologies (<http://www.waterpuretech.com/Technology.html> ))
- Anaerobic Digestion, including bio-gas generation and combustion to produce heat and electricity, and possible purification of the bio-gas into CNG and/or LNG for use as a vehicle fuel.
- Biocatalysts and enzymes (e.g., <http://www.bwisolutions.com/>)
- BION Environmental Technologies, Inc. (<http://www.biontech.com>)
- Circulators and aerators for manure ponds
- Composting
- Constructed Wetlands
- Dehydration and Pelletizing
- Earthrenew Organics Ltd.
- Environmental management (e.g., water sprinkling of drylot pens, shade, frequent manure harvest from corrals, stocking rates)
- Gasification (high efficiency combustion)
- Nitrification/Denitrification
- Nutritional modifications
- Phosphorous precipitation
- Purple sulfur (“red”) bacteria
- Reciprocating wetlands (aerobic/anaerobic treatment with denitrification)
- Salt removal (precipitation, reverse osmosis)
- Solid Separation

## **Technology Assessment**

Description and discussion of each technology, utilizing the criteria listed above.

### **Technology #1**

Environmental Impacts

Air pollutants: NH<sub>3</sub>, VOCs, CH<sub>4</sub>

Nutrients: N, P

Salts

Others: odors, pathogens

Energy production

Economic performance: costs, and value-added products

Quality of Supporting Data

Development Status of the Technology

Repeat for Technology #2, #3, etc.

Summary tables comparing all technologies studied

## **Conclusions and Recommendations**

Discussion of technologies most likely to improve treatment and management of dairy manure in the San Joaquin Valley

Recommendations for additional research

## **References**

## **Appendices**

- A: Company Information
- B: Supporting Data for Environmental Assessment
- C: Supporting Data for Economic Evaluation